

L 1485994 / double code

N 65 88454

NASA. Goddard Space
Flight Center, Greenbelt, Md.

X64-5056 (P)
Code NO. NC 64-5056 (P)

10p

LOW LEVEL DECAmETER EMISSIONS FROM JUPITER (SA TAKS 458)

During September and October, 1963, the 26.3 Mc/s radiation from Jupiter was systematically observed with the University of Maryland decametric antenna at Clark Lake, California. In view of the particularly high sensitivity of this instrument ($\sim 5 \times 10^{-24}$ $\text{wm}^{-2}(\text{c/s})^{-1}$) special attention was given to the determination of how the apparent properties of the Jovian decameter radiation might be modified by the ability to detect noise bursts considerably weaker than those observed by most other workers. A preliminary report of the results of this study follows.

The antenna is a Christiansen-type array consisting of 8 elements spaced at intervals along a two-mile E-W base line. Each element is an N-S colinear array of 19 full-wave dipoles. The response pattern of the array is multilobed -- the individual lobes having half-power widths of 10° E-W by 3° N-S and E-W spacing of 1.5° . The declination of the response pattern can be set between 3° N and 63° N by adjusting the phase difference between the individual dipoles of the array. Therefore as a discrete radio source moves across the sky at sidereal rate it passes through one of the lobes of the grating response every six minutes. This feature simplifies identification of the noise bursts since the times at which bursts from the planet are detected must correspond to the passage of the source across one of the lobes of the response pattern. We note in this regard that the average difference between the observed and calculated lobe crossing times was about ± 18 sec. which corresponds to apparent angular shifts in

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[1963] 10p ref 2*

Submitted for Publication



right ascension of about 4'. Since ionospheric refraction normally causes position shifts of this order in the case of "radio star" observations, we can say that within the limits of our system the noise bursts did indeed originate at the planet.

The receiving system is a Ryle-Vonberg radiometer having a 35 kc/s bandwidth and an integration time of 2 sec.

Observations were made nightly from September 19 to October 11, inclusive, with an average observing time of 3.3^h per night. Since meridian transit occurred between 00^h and 02^h local time, the observations were free from interference due to solar noise, and man-made interference was at a minimum.

The variation of the 26.3 Mc/s noise storms with system III central meridian longitude is shown in Figure 1. The histogram gives the longitudinal distribution of occurrence probability which is found by taking the ratio of the number of noise bursts observed to the number of times the planet passed one of the lobes of the grating response for each 10° longitude interval. Although the observations are not sufficient to insure that the data are statistically complete one can still distinguish the three regions discussed by Douglas (1960): Region 1, 70° to 190°, Region 2, 190° to 265°, and Region 3, 265° to 330°. One notices that the probability histogram peaks are somewhat broadened in comparison to the results of other workers who have found the peaks grow narrower toward higher frequencies. In confirmation of a suggestion by Barrow (1962), it appears that detection of bursts at all longitudes within the three main regions only requires sufficient sensitivity at the higher frequencies. On the

other hand, this result does not lend credence to a theoretical prediction by Ellis and McCulloch (1963) that the 26 Mc/s histogram peaks should be confined to narrow longitude bands. The significance of weak bursts will be discussed in more detail later.

It is significant that the quadrant from 330° to 70° is completely void of activity. Although some workers have reported observing a few weak bursts in this region, especially below 12 Mc/s, Douglas and Smith (1963) report that the Yale workers have never detected storms at 22.2 Mc/s having flux greater than $10^{-21} \text{ wn}^{-2}(\text{c/s})^{-1}$ between longitudes 350° and 70° . In the case of our observations, no activity of flux greater than $5 \times 10^{-24} \text{ wn}^{-2}(\text{c/s})^{-1}$ was detected. All flux measurements were made relative to the discrete source Hercules A (3C348) which has nearly the same declination as did Jupiter during these observations. The 26.3 Mc/s flux of Hercules A was taken to be $2 \times 10^{-23} \text{ wn}^{-2}(\text{c/s})^{-1}$ (Conway, Kellermann, and Long, 1963).

One of the primary objectives of this study was to determine the number-intensity distribution of noise bursts and to find, within instrumental limits, if there was a threshold below which bursts did not occur. We must emphasize that here "burst" is defined as an abrupt increase in antenna temperature occurring at the time Jupiter transits one of the lobes of the antenna response pattern. No attempt has been made to further analyze any fine structure within the 40 seconds required for a source to drift between the half-power points of a single lobe. Furthermore, only those bursts detected when the planet was between the half-power points of the N-S envelope of the antenna response pattern were considered for this analysis. This condition was satisfied for an average of 1.3^h per night.

histogram in Figure 2a shows the intensity distribution for all bursts observed. One division on the abscissa corresponds to approximately $10^{-22} \text{ wn}^{-2}(\text{c/s})^{-1}$. The most striking features of this diagram are the large concentration of bursts at low intensities and the secondary peak at the high intensity end of the figure. Similar plots were made using only bursts from one of the three major longitude regions, and although the statistics were poorer, the same general shape was obtained in each case. This result would suggest that at 26.3 Mc/s the Jupiter storms are composed primarily of "weak" bursts (flux less than $10^{-22} \text{ wn}^{-2}(\text{c/s})^{-1}$) and a smaller number of "strong" bursts (flux greater than $7 \times 10^{-22} \text{ wn}^{-2}(\text{c/s})^{-1}$) with only rare activity at intermediate intensities.

We examine the intensity distribution of the weak bursts in more detail in Figure 2b. Now the major portion of the bursts are clustered at intensities just above $10^{-23} \text{ wn}^{-2}(\text{c/s})^{-1}$ or at least two times the sensitivity of our antenna. A secondary peak appears around $9 \times 10^{-23} \text{ wn}^{-2}(\text{c/s})^{-1}$. As before, the same general shape of the intensity distribution histogram is obtained when using bursts from a single longitude region.

Using the burst intensity distribution data of Figure 2 we may now make some general assumptions regarding the flux spectra of "typical" noise bursts. Since the Florida workers (Smith, et al; 1963) have suggested that the flux density falls faster than f^{-5} as frequency, f , increases above 17 Mc/s, we shall assume a spectral index of -5.5. If the flux spectra obtained by extrapolation of the 26.3 Mc/s data to lower frequencies are indeed typical, then they offer an explanation of the fact that several observers report that the noise storms

are generally well in excess of the sensitivity limits of their equipment. Taking the flux density of a strong burst to be $6 \times 10^{-22} \text{ w m}^{-2}$ $(\text{c/s})^{-1}$, we find that at 18 Mc/s such a burst would have a flux density of about $6 \times 10^{-21} \text{ w m}^{-2} (\text{c/s})^{-1}$ in rough agreement with other reports (e.g., Smith, et al; 1963). The weak bursts having a 26.3 Mc/s flux density less than $10^{-22} \text{ w m}^{-2} (\text{c/s})^{-1}$, however, would not exceed $9.1 \times 10^{-21} \text{ w m}^{-2} (\text{c/s})^{-1}$ at 18 Mc/s, and, therefore, would not be detected by many of the instruments presently used for Jupiter studies.

Summary

A

When the 26.3 Mc/s radiation from Jupiter is observed with sufficient sensitivity to detect bursts as weak as $5 \times 10^{-24} \text{ w m}^{-2} (\text{c/s})^{-1}$, the variation of burst occurrence with system III longitude is found to have the same general shape as reported by other workers. Although the occurrence probability histogram peaks are somewhat broadened in comparison to other less sensitive surveys in this frequency range, the region from 330° to 70° longitude still appears completely void of activity. Preliminary analysis of the burst intensity distribution at 26.3 Mc/s suggests two components of the emission. One component is comprised of a large number of weak bursts of flux densities between 10^{-23} and $10^{-22} \text{ w m}^{-2} (\text{c/s})^{-1}$. The other, secondary component is comprised of strong bursts of flux density greater than $7 \times 10^{-22} \text{ w m}^{-2}$ $(\text{c/s})^{-1}$ and may correspond to the radiation commonly observed by other workers at lower frequencies. It now remains to supplement these data with further observations at 26.3 Mc/s and new observations with comparable sensitivity at lower frequencies. If the suggestion of two components to the decameter emission is supported, then one must consider the possibility of radiation in two modes, from two radiators.

bolts, or even by two different mechanisms.

The Clark Lake Radio Observatory is operated by the University of Maryland through the support of the National Science Foundation.

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FIGURE CAPTIONS

- Fig. 1. Variation of 26.3 Mc/s burst occurrence with longitude.
Arrows indicate location of the major regions at 22.2
Mc/s according to Douglas (1960) for comparison.
- Fig. 2a. Number-intensity distribution of 26.3 Mc/s noise bursts.
b. Distribution of bursts falling in first interval of
upper histogram.

CENTRAL MERIDIAN LONGITUDE (SYSTEM III 1957.0)



